CLAIMS

[Claim(s)]

[Claim 1]it is a transfer method which transfers on a substrate an image of a pattern of prescribed shape containing a linear pattern via a projection optical system -- a portion corresponding to a pattern of said prescribed shape is made into a dimming part, and other portions with the 1st mask pattern made into a transparent part. Said linear pattern and two or more transmission patterns which have comparable line width substantially are periodically arranged crosswise [of said linear pattern], respectively so that a portion corresponding to said linear pattern may be touched, And fields other than said transmission pattern near the portion corresponding to said linear pattern use at least the 2nd mask pattern made into a dimming part, Via said projection optical system, carry out alignment of the image of said two mask patterns mutually, and transfer it one by one, on said substrate, and. A transfer method, wherein intensity distribution in an optical Fourier transformation plane to a pattern of a transfer object of an illumination-light study system uses

Lighting Sub-Division conditions at the time of transferring an image of said 2nd mask pattern as deformation illumination powerful in a field of this outside near the optic axis.

[Claim 2]A transfer method of Claim 1 description, wherein line width of a portion corresponding to said linear pattern in said 1st mask pattern is 1 time - twice the line width of said linear pattern.

[Claim 3]When said linear pattern is used as the 1st linear pattern, a pattern of said prescribed shape, Further the 2nd linear pattern that makes a direction which intersects perpendicularly with a long side direction of said 1st linear pattern a long side direction an implication and said 2nd mask pattern, It has line width substantially comparable as said 2nd linear pattern respectively so that a portion corresponding to said 2nd linear pattern may be touched, Two or more transmission patterns arranged periodically crosswise [of this linear pattern] are included further, Conditions of said deformation illumination at the time of transferring an image of said 2nd mask pattern, Intensity distribution of illumination light in said optical Fourier transformation plane, Claim 1 becoming distribution centering on four positions which met in the

direction rotated 45 degrees substantially, respectively from a direction corresponding to a long side direction of said 1st and 2nd linear patterns centering on said optic axis, or a transfer method given in two.

[Claim 4]A transfer method of Claim 3 description setting up more greatly than a light exposure when transferring said 1st mask pattern a light exposure when transferring said 2nd mask pattern.

[Claim 5]When said linear pattern is used as the 1st linear pattern, a pattern of said prescribed shape, The 2nd linear pattern that makes a direction which intersects a long side direction of said 1st linear pattern a long side direction so that a portion corresponding to an implication and said 2nd linear pattern may be touched further, Said 2nd linear pattern and two or more transmission patterns which have comparable line width substantially are arranged periodically crosswise [of said 2nd linear pattern], respectively, And fields other than said transmission pattern near the portion corresponding to said 2nd linear pattern use further at least the 3rd mask pattern made into a dimming part, Via said projection optical system, carry out alignment of the image of said three mask patterns mutually, and transfer it one by one, on said substrate, and.

Lighting Sub-Division conditions at the time of transferring an image of said 2nd mask pattern, and an image of said 3rd mask pattern, A direction to which a long side direction of said 1st linear pattern and intensity distribution of illumination light in said optical Fourier transformation plane cross at right angles, respectively, And Claim 1 considering it as deformation illumination used as distribution centering on two positions which are separated from said optic axis in the direction corresponding to a direction which intersects perpendicularly with a long side direction of said 2nd linear pattern or a transfer method given in two.

[Claim 6]A transfer method of Claim 5 description setting up more greatly than a light exposure when transferring said 1st mask pattern a light exposure when transferring said 2nd mask pattern.

[Claim 7]In a transfer method which transfers an image of an isolation linear pattern on a substrate via a projection optical system, Irradiate with the 1st isolation pattern that made said linear pattern a dimming part, and the 2nd periodic pattern that consists of two or more transmission patterns by illumination light, respectively, and on said substrate A dimming part of said 1st pattern, A transfer method characterized by

carrying out multiple exposure of said substrate using said 1st and 2nd patterns so that one dimming part inserted into said two or more transmission patterns may lap.

[Claim 8]A transfer method of Claim 7 description changing intensity distribution of said illumination light on an optical Fourier transformation plane to said pattern in an illumination-light study system which irradiates said 1st and 2nd patterns with said illumination light, respectively by said 1st pattern and said 2nd pattern.

[Claim 9]A transfer method of Claim 8 description raising intensity distribution of said illumination light on the outside rather than a field including an optic axis of said illumination-light study system when exposing said substrate using said 2nd pattern.

[Claim 10]A transfer method of Claim 7-9 changing a light exposure when transferring said 1st pattern, and a light exposure when transferring said 2nd pattern given in any 1 clause.

[Claim 11]A transfer method of Claim 10 description making a light exposure when transferring said 2nd pattern larger than a light exposure when transferring said 1st pattern.

[Claim 12]A transfer method of Claim 11 description which line width of said linear pattern is a resolution limit grade of said projection optical system, and line width of said 1st pattern is about 1 time - twice the line width of said linear pattern, and is characterized by line width of said 2nd pattern being comparable as line width of said linear pattern.

[Claim 13]A transfer method of Claim 7-9, wherein a dimming part of said 1st and 2nd patterns is a shade part or a translucent section to which about 180 degrees of phases of the transmitted light are shifted, respectively given in any 1 clause.

[Claim 14]Line width of said linear pattern is a resolution limit grade of said projection optical system, and line width of said 1st pattern is about 1 time - twice the line width of said linear pattern, A transfer method of Claim 7-9, wherein line width of said 2nd pattern is comparable as line width of said linear pattern given in any 1 clause.

[Claim 15]Said 1st and 2nd patterns are formed in a mask mutually different, respectively, and said two masks, A transfer method of Claim 7-9 characterized by being arranged one by one at the object face side of said projection optical system so that a longitudinal direction of said 1st

pattern and period directions of said 2nd pattern may intersect perpendicularly mostly given in any 1 clause.

[Claim 16]A transfer method which transfers an image of an isolation linear pattern on a substrate via a projection optical system, comprising:

It is [said linear pattern and] the 1st pattern of identical shape substantially.

It is [said linear pattern and] a straight part of the same line width substantially.

[Claim 17]A transfer method of Claim 16 description changing an exposing condition of said substrate when transferring said 1st pattern, and an exposing condition of said substrate when transferring said 2nd pattern.

[Claim 18]A transfer method of Claim 17 description, wherein said exposing condition includes intensity distribution of said illumination light on an optical Fourier transformation plane to said pattern in an illumination-light study system which irradiates said 1st and 2nd patterns with said illumination light, respectively.

[Claim 19]A transfer method of Claim 18 description raising intensity distribution of said illumination light on the outside rather than a field including an optical axis of said illumination-light study system when exposing said substrate using said 2nd pattern.

[Claim 20]A transfer method of Claim 17 description, wherein said exposing condition makes a light exposure when transferring said 2nd pattern larger than a light exposure when transferring said 1st pattern including a light exposure of said substrate.

[Claim 21]A transfer method of Claim 17 description, wherein line width of said 1st pattern is about 1 time - twice the line width of said linear pattern.

[Claim 22]A transfer method of Claim 21 description, wherein said 2nd pattern contains a transparent part to which about 180 degrees of phases of said illumination light are shifted.

[Claim 23]A transfer method of Claim 22 description, wherein said transparent part is a translucent section which dims said illumination light.

[Claim 24]A transfer method of Claim 16-23, wherein, as for said linear pattern, line width in an end has become thicker than the central part at

least given in any 1 clause.

[Claim 25]A transfer method of Claim 24 description, wherein said linear pattern is a gate electrode pattern.

[Claim 26]In an exposure device which has an illumination-light study system which illuminates a predetermined mask, and a projection optical system which transfers an image of a pattern of said mask on a substrate, Lighting Sub-Division conditions of said illumination-light study system Deformation illumination with intensity distribution powerful in a field of this outside near the optic axis in an optical Fourier transformation plane of a pattern of an exposure object, The Lighting Sub-Division conditional-control system switched to any with other Lighting Sub-Division they are, and a pattern selecting arrangement which chooses any of two or more mask patterns as a pattern of said mask, An alignment system which performs mutual alignment of two or more mask patterns chosen one by one with this pattern selecting arrangement, An exposure device having an exposure control system which switches said Lighting Sub-Division conditions via said Lighting Sub-Division conditional-control system, and performs multiple exposure according to

a pattern selected with said pattern selecting arrangement.

[Claim 27]An illumination-light study system which illuminates a predetermined mask, and a projection optical system which transfers an image of a pattern of said mask on a substrate, Lighting Sub-Division conditions of said illumination-light study system Deformation illumination with intensity distribution powerful in a field of this outside near the optic axis in an optical Fourier transformation plane of a pattern of an exposure object, The Lighting Sub-Division conditional-control system switched to any with other Lighting Sub-Division they are, and a pattern selecting arrangement which chooses any of two or more mask patterns as a pattern of said mask, An alignment system which performs mutual alignment of two or more mask patterns chosen one by one with this pattern selecting arrangement, A manufacturing method of an exposure device finishing by position relations setting up an exposure control system which switches said Lighting Sub-Division conditions via said Lighting Sub-Division conditional-control system, and performs multiple exposure according to a pattern selected with said pattern selecting arrangement.

[Claim 28]It is a manufacturing method of a device with which a circuit pattern of prescribed shape containing a linear pattern is formed in a certain layer, Claim 1, 2, 7-9, a manufacturing method of a device transferring said circuit pattern to said layer using a transfer method of 16-23 given in any 1 clause.

[Claim 29]A manufacturing method of a device of Claim 28 description, wherein said linear pattern is a gate electrode pattern of a field effect transistor.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

technical field lithography for this invention to form the minute pattern of electron devices, such as Integrated Circuit Sub-Division, image sensors (CCD etc.), or a liquid crystal display element, for example -- it is in process and is related with the transfer method used when transferring the image of a mask pattern on substrates, such as a wafer, and an exposure device.

Background art Conventionally minute patterns, such as Integrated Circuit Sub-Division, After carrying out projection exposure of the image of the original plate pattern drawn on the reticle as a mask on substrates, such as a wafer in which it was applied to the photoresist as a film, using projection aligners (stepper etc.), If it is a positive resist with development, after removing the film of an exposed part, it is formed by passing through a predetermined work process. For the miniaturization of patterns, such as the Integrated Circuit Sub-Division, i.e., the improvement in a degree of location, improvement in the resolution of the projection optical system with which the projection aligner is equipped is required.

Wavelength of the illumination light (exposing light) is set to lambda, it sets a numerical aperture to NA, and, generally the resolution of a projection optical system is proportional to lambda/NA. Although the exposure wavelength lambda which is in use now is 248 nm of KrF excimer laser light, use of ArF excimer laser light (wavelength of 193 nm) is also considered from now on. However, since there is no suitable ** material which can be used as a lens which constitutes a projection optical

system when short wavelength formation is carried out more, it becomes difficult to constitute a projection optical system using refractive media. Since it is large to about 0.7, it is impossible on the other hand, for the numerical aperture NA of the present projection optical system to desire the further improvement in the numerical aperture NA.

When transferring a actual minute pattern, although the depth of focus (DOF) is also important, the depth of focus will decrease by the short wavelength formation of the exposure wavelength lambda, and all of improvement in the numerical aperture NA. Although the depth of focus changes also with kinds of pattern to transfer, In the case of the high density pattern (period pattern) which a pattern approaches comparatively and is located in a line, As indicated by Japan JP,H4-101148,A and corresponding US,5638211,B, Japan JP,H5-206007,A, and corresponding US,5719704,B, In the optical Fourier transformation plane to the reticle pattern in an illumination-light study system, the resolution and depth of focus can be substantially raised by controlling the form of the luminous energy distribution of the illumination light, namely, performing deformation illumination which controls the

incidence angle to the reticle of the illumination light.

On the other hand, the linear pattern (small-gage wire pattern) of the minute line width which is called an isolated line and arranged comparatively in isolation to other patterns is a stake pattern that especially the depth of focus obtains. And in electron devices, such as Integrated Circuit Sub-Division and a liquid crystal display element, the pattern called the gate pattern which opts for the performance of the device contains the isolated line.

As technology which raises resolution and the depth of focus, to an isolated line, For example, an auxiliary pattern is added to the both ends of an isolated line, and also there is the method (it calls the following "auxiliary pattern method") of using together deformation illumination (zona-orbicularis Lighting Sub-Division is included) as indicated by Japan JP,H4-268714,A and corresponding US,5357311,B. this method -- the imaging characteristic of an isolated line -- being certain -- a grade improvement can be carried out. The method (it calls the following "synthetic exposing method") of forming an isolated line by synthetic exposure (multiple exposure) with an isolated line and a period pattern is

also proposed as indicated by Japan JP,H4-273427,A. Also in this method, resolution and the depth of focus are raised by using deformation illumination when exposing a period pattern, and the resolution and the depth of focus of an image of an isolated line are improving substantially synthetically.

The method for conventionally raising the resolution and the depth of focus of an image of an isolated line which are contained in a gate pattern etc. is proposed like the above. However, in the former auxiliary pattern method, there was a case where improvement in the resolution of the image of an isolated line and the depth of focus was not enough. Although the latter synthetic exposing method was able to respond mostly to the imaging characteristic demanded conventionally, when exposing the circuit pattern to be miniaturized further from now on with high precision, there are the following problems.

the width for connection with a circuit pattern of the gate pattern with actual one of them is wide at one of the ends of the isolated line instead of a mere isolated line, or both the ends -- pile up -- business, since it has a pattern, It is that it is not easy to disassemble into an isolated line and a

period pattern the gate pattern to be miniaturized further especially from now on.

Although deformation illumination is used when exposing one period pattern of two kinds of patterns compounded as another problem for much more improvement in resolution and the depth of focus, In that case, it is mentioned that it is necessary to restrict the illumination luminous flux in the optical Fourier transformation plane in the above-mentioned illumination-light study system to the small field distant from the optic axis as much as possible. Thus, by the Fourier transformation plane in the illumination-light study system, if illumination luminous flux is extracted small, According to it, the breadth of the light flux in the inside of a projection optical system will also become small, as a result, a projection optical system will be locally heated by exposing light flux, local thermal expansion and refractive index change will arise, and the imaging characteristic of a projection optical system will deteriorate delicately gradually.

This invention sets it as the 1st purpose to provide the transfer method which can transfer the image of a circuit pattern which consists of a linear

pattern and a wide pattern of this end like a gate pattern on substrates, such as a wafer, with high precision in view of this point.

This invention sets it as the 2nd purpose to provide the transfer method which can transfer the image of a pattern like an isolated line on a substrate with high precision.

This invention sets it as the 3rd purpose to provide the transfer method which can control degradation of the imaging characteristic of a projection optical system, when using deformation illumination for a part of Lighting Sub-Division conditions.

An object of this invention is also to provide the manufacturing method of the device which can manufacture a device with high precision using the exposure device which can use such a transfer method, the efficient manufacturing method of this exposure device, and such a transfer method.

Indication of invention The 1st transfer method by this invention, It is a transfer method which transfers the image of the pattern (P1) of the prescribed shape containing a predetermined linear pattern (P1a) on a substrate (16) via the projection optical system, So that the portion (A1)

corresponding to the pattern of the prescribed shape may be made into a dimming part and other portions (35) may touch the portion (P1a') corresponding to the 1st mask pattern (9A) made into the transparent part, and its linear pattern, The linear pattern and two or more transmission patterns (B1) which have comparable line width substantially are arranged periodically crosswise [of the linear pattern], respectively, And fields other than the transmission pattern near the portion corresponding to the linear pattern use at least the 2nd mask pattern (9B) made into the dimming part (32), Via the projection optical system, carry out alignment of the image of these two mask patterns mutually, and transfer it one by one, on the substrate, and. The intensity distribution in the optical Fourier transformation plane (5) to the pattern of the exposure object of an illumination-light study system uses the Lighting Sub-Division conditions at the time of exposing the image of that 2nd mask pattern as deformation illumination powerful in the field of this outside near the optic axis.

Since the image of a period pattern more detailed than the resolution limit under other Lighting Sub-Division can be projected with high precision

with the deep depth of focus by using deformation illumination in this this invention, It faced dividing the pattern of the prescribed shape into the 1st and 2nd mask patterns, the transmission pattern (B1) arranged periodically only at the position which is equivalent to the 2nd mask pattern near the linear pattern was formed, and other portions were made into the dimming part.

As a result, the form of the 1st mask pattern can be substantially [as the pattern of the prescribed shape which should be transferred] the same, and most newly created pattern information cannot be found. On the other hand, what is necessary is to arrange the 2nd mask pattern only around a linear pattern, and as a whole, the amounts of creation of pattern information are few, and end. when the pattern of the prescribed shape is a gate pattern, the end of a linear pattern should lay on top of the 2nd mask pattern -- business -- it is not necessary to form the pattern with wide width like a pattern, and means that the gate pattern was substantially disassembled into the isolated line and the period pattern easily

The transmission pattern contained in the 2nd mask pattern, It is only a

very small period pattern part around a linear pattern, and since the transmissivity (rate that a transmission pattern occupies) of the whole pattern becomes low, when it performs deformation illumination using the 2nd mask pattern, light volume's which penetrates the inside of a projection optical system decreases. For this reason, even if image formation light flux concentrates locally in a projection optical system with deformation illumination, a possibility that an optical system may be heated locally and may change disappears, and it becomes possible to use the deformation illumination of high resolution, being stabilized.

It is desirable to set up more greatly than a light exposure when transferring the 1st mask pattern a light exposure when transferring the 2nd mask pattern.

Next, in the transfer method with which the 2nd transfer method by this invention transfers the image of an isolation linear pattern on a substrate via a projection optical system, The 1st isolation pattern (A1) that made the linear pattern the dimming part, So that the 2nd periodic pattern (B1) that consists of two or more transmission patterns may be illuminated by the illumination light, respectively and the dimming part of the 1st pattern

and one dimming part inserted into two or more of the transmission patterns may lap on the substrate, Multiple exposure of the substrate is carried out using the 1st and 2nd patterns.

According to this invention, the final line width of that isolation linear pattern is correctly prescribed by transfer of the 2nd periodic pattern, and since unnecessary cyclic patterns are covered with transfer of the 1st pattern, they can transfer an isolation linear pattern with high precision.

It is desirable to change a light exposure when transferring a light exposure and the 2nd pattern when transferring the 1st pattern.

The line width of the 1st pattern is about 1 time - twice the line width of said linear pattern, and, as for the line width of the 2nd pattern, it is desirable that it is comparable as the line width of said linear pattern.

Next, in the transfer method with which the 3rd transfer method by this invention transfers the image of an isolation linear pattern on a substrate via a projection optical system, It irradiates with the 1st pattern (A1) of identical shape, and the linear pattern and the 2nd periodic pattern (B1) that includes the straight part of the same line width substantially by the illumination light, respectively as substantially as the linear pattern,

Multiple exposure of the substrate is carried out using the 1st and 2nd patterns so that the straight part of the 1st pattern and its 2nd pattern may lap on the substrate. According to the 3rd transfer method of this this invention, an isolation linear pattern can be transferred with high precision like the 2nd transfer method of this invention.

When transferring the 1st pattern, it is desirable to change the exposing condition and the exposing condition of a substrate when transferring the 2nd pattern of the substrate.

The inside of the illumination-light study system to which the exposing condition irradiates the 1st and 2nd patterns with the illumination light, respectively, When exposing the substrate using the 2nd pattern including the intensity distribution of the illumination light on the optical Fourier transformation plane to the pattern, it is more desirable than a field including the optical axis of the illumination-light study system to raise the intensity distribution of the illumination light on the outside.

As for the exposing condition, it is desirable to include the light exposure of the substrate.

It is desirable that it is a translucent section in which the transparent part

dims the illumination light including the transparent part to which the 2nd pattern shifts about 180 degrees of phases of the illumination light.

As for the linear pattern, it is desirable for the line width in an end to be thicker than the central part at least. And the linear pattern is a gate electrode pattern as an example.

In each of above-mentioned invention, the line width of the linear pattern is line width about a resolution limit substantially [projection optical system] as an example. With such a linear pattern, when it illuminates on the Lighting Sub-Division conditions (usually Lighting Sub-Division) using the illumination light which passes through the almost circular field centering on an optic axis in the optical Fourier transformation plane to a mask pattern as an example, The width of the ideal projection image says 1 of the theoretical resolution limit of the projection optical system / about 2 to 5 times the pattern.

Next, in the exposure device which has an illumination-light study system (1-4, 6A, 6B, 7) in which the exposure device by this invention illuminates a predetermined mask, and a projection optical system (14) which transfers the image of the pattern of the mask on a substrate, The

Lighting Sub-Division conditions of that illumination-light study system Deformation illumination with intensity distribution powerful in the field of this outside near the optic axis in the optical Fourier transformation plane (5) of the pattern of an exposure object, The Lighting Sub-Division conditional-control system (23, 42, 43) switched to any with other Lighting Sub-Division they are, A pattern selecting arrangement (11-13) which chooses any of two or more mask patterns (9A, 9B) they are as a pattern of the mask, The alignment system (8A, 8B, 25) which performs mutual alignment of two or more mask patterns chosen one by one with this pattern selecting arrangement, According to the pattern selected with the pattern selecting arrangement, it has an exposure control system (27) which switches the Lighting Sub-Division condition via the Lighting Sub-Division conditional-control system, and performs multiple exposure. With this exposure device, the 1st and 2nd transfer methods of this invention can be enforced.

Next, the illumination-light study system (1-4, 6A, 6B, 7) in which the manufacturing method of the exposure device by this invention illuminates a predetermined mask, The projection optical system (14)

which transfers the image of the pattern of the mask on a substrate, The Lighting Sub-Division conditions of that illumination-light study system Deformation illumination with intensity distribution powerful in the field of this outside near the optic axis in the optical Fourier transformation plane (5) of the pattern of an exposure object, The Lighting Sub-Division conditional-control system (23, 42, 43) switched to any with other Lighting Sub-Division they are, A pattern selecting arrangement (11-13) which chooses any of two or more mask patterns (9A, 9B) they are as a pattern of the mask, The alignment system (8A, 8B, 25) which performs mutual alignment of two or more mask patterns chosen one by one with this pattern selecting arrangement, According to the pattern selected with the pattern selecting arrangement, it finishes by position relations setting up the exposure control system (27) which switches the Lighting Sub-Division condition via the Lighting Sub-Division conditional-control system, and performs multiple exposure.

The manufacturing method of the device by this invention is a manufacturing method of the device with which the circuit pattern of the prescribed shape containing the pattern in which the projection image of

the projection optical system (14) of the exposure device used has the line width about a resolution limit substantially in a certain layer is formed, The exposure device performs exposure to the layer using the exposure method by this invention. By this, the pattern of the line width about the resolution limit of the projection optical system can be formed with high precision. The linear pattern is a gate electrode pattern of a field effect transistor, for example.

The best form for inventing With reference to Drawings, it explains per example of the suitable embodiment of this invention hereafter.

Drawing 1 shows the projection aligner used by this example, in this drawing 1, it is reflected by the mirror 3 as illumination-light IL1, and illumination-light IL0 as exposing light which emitted the exposure light source 1 enters into the illuminance distribution plastic surgery optical system 4, after having the shape of beam prepared by the relay optical system 2. As the exposure light source 1, although the source of ArF excimer laser light (wavelength of 193 nm) is used in this example, A KrF excimer laser (wavelength of 248 nm), F_2 laser (wavelength of 157 nm), Ar_2 laser (wavelength of 126 nm), or the harmonic generation equipment

of an YAG laser can be used in addition to it.

The illuminance distribution plastic surgery optical system 4 of this example is arranged, enabling the fly eye lens 41 as an optical integrator (homogenizer), and the free rotation to this projection surface 5, and. It has the rotor plate 42 in which two or more aperture diaphragms (it calls the following "sigma diaphragm") have been arranged centering on the axis of rotation, and the drive motor 43 made to rotate this rotor plate 42. So that the projection surface 5 of the fly eye lens 41 may have a relation of the optical Fourier transform to the pattern surface side of the reticle as a mask of an exposure object, the rotor plate 42 may be rotated and the center of sigma diaphragm of a request may agree in optic-axis AX1 of an illumination-light study system, Desired Lighting Sub-Division conditions can be set up by installing the sigma diaphragm in the projection surface 5.

In the state where it installed in the projection surface 5, respectively as shown in the rotor plate 42 at drawing 5 (A) - (E). So that the sigma diaphragm 44 which has the four circular openings 44a-44d formed by the equiangular distance focusing on optic-axis AX1 into the gobo, the

sigma diaphragm 45 which has the circular opening 45a centering on optic-axis AX1, and optic-axis AX1 may be inserted into a prescribed direction. The sigma diaphragm 46 which has the two formed small circular openings 46a and 46b, and the sigma diaphragm 47 which has the openings 47a and 47b of the form where 90 degrees of the sigma diaphragm 46 was rotated are arranged. Drawing 5 (A) is a sectional view which meets AA line of drawing 5 (B). It is prescribed by the position of each opening of these sigma diaphragms 44-47, the intensity distribution, i.e., the Lighting Sub-Division conditions, of the illumination light at the time of passing the optical Fourier transformation plane of the reticle pattern of an exposure object, and the incidence angle of the illumination light which enters into a reticle pattern, and distribution of a direction are specified. The sigma diaphragms 44, 46, and 47 are sigma diaphragms for the illumination light to perform deformation illumination which are the Lighting Sub-Division conditions which pass through the field which does not contain optic-axis AX1 in the optical Fourier transformation plane, respectively.

It returns to drawing 1 and the information on optimal sigma diaphragm

under sigma diaphragm 44-47 is memorized as a table by the main control system 27 which carries out control control of the operation of the whole equipment according to period directions and the degree of detail of a reticle pattern of an exposure object. Then, the main control system 27 supplies the information on the optimal sigma diaphragm for the reticle pattern of an exposure object to the exposure control system 23 before exposure, and the exposure control system 23 sets optimal sigma diaphragm as the projection surface 5 of the fly eye lens 41 via the drive motor 43. The exposure control system 23 also performs control of the luminescent state of the exposure light source 1. To various reticle patterns, about the form of optimal sigma diaphragm. For example, as long as it is stated to Japanese **** JP,H4-101148,A, US,5638211,B, and US,5335044,B in detail and the national law of the designated state which specified by application at the its native country time, or the selected elected State allows, The indication of the above-mentioned gazette and an United States patent is used, and it is made a part of description of the text.

Illumination-light IL2 ejected from the illuminance distribution plastic

surgery optical system 4 illuminates the illuminated field of the pattern surface side of the 1st reticle 9A as a mask in the state of drawing 1 through the condenser lens system 6A, the mirror 7, and the condensing lens 6B. By the basis of the illumination-light IL2, projection exposure of the image of the pattern of the reticle 9A is carried out to the surface of wafer (wafer)16 on which it is the projecting magnification beta (beta is 1/4, and 1 / 5 grades), and the photoresist as a substrate was applied via the projection optical system 14. The field diaphragm (reticle blind) etc. which specify an illuminated field actually are contained in the condenser lens system 6A. The projection surface 5 of the fly eye lens 41 is an optical Fourier transformation plane of the pattern surface side of the reticle of an exposure object about the optical system which consists of the condenser lens system 6A, the mirror 7, and the condensing lens 6B. The aperture diaphragm 15 is arranged at the optical Fourier transformation plane (pupil surface) to the pattern surface side of the reticle 9A within the projection optical system 14.

Adsorption maintenance of the reticle 9A is carried out on the reticle holder 10A on the reticle stage 11, and 10B. By this example, the

predetermined pattern image to the wafer 16 is exposed by synthetic exposure (multiple exposure) of two or more reticle patterns like the after-mentioned. Then, it is possible to expose adsorption maintenance being carried out and the 2nd reticle 9B exchanging these reticles for the field close to the reticle 9A on the reticle stage 11 via the reticle holders 10B and 10C. Hereafter, in a flat surface vertical to optic-axis AX2 of the projection optical system 14, in parallel with the space of drawing 1, a Y-axis is taken at right angles to the space of drawing 1, and the X-axis is explained.

First, on the reticle stage 11, the reticles 9A and 9B approach in the direction of X, and are laid. And it can move by stroke long in the direction of X onto the reticle base 12, and the reticle stage 11 is laid in the direction of X, the direction of Y, and the hand of cut in the prescribed range, enabling free positioning. The two-dimensional position of the reticle stage 11 is measured by the laser interferometer 13 which countered the moving mirror 13m and this, and has been arranged, and the reticle stage drive system 21 controls operation of the reticle stage 11 based on this measurement value and the control information from the

main control system 27.

One pair of reticle alignment microscopes (henceforth "RA microscope") 8A and 8B are installed under the periphery of the condensing lens 6B, and the imaging signal of the RA microscopes 8A and 8B is supplied to the alignment signal processor 26. At the time of reticle alignment, the RA microscopes 8A and 8B, respectively The alignment mark of the reticle 9A (or reticle 9B), And the image of the reference mark by the side of the wafer stage corresponding to this is picturized, in the alignment signal processor 26, the amount of position gaps of these two pairs of marks is computed, and the main control system 27 is supplied. By positioning the reticle stage 11 so that those amounts of position gaps may become the minimum symmetrically, for example, position relations can be maintained and, as for the main control system 27, alignment of the pattern image of both the reticles 9A and 9B can be carried out with high precision. However, since the position (an X coordinate is included) of the reticle stage 11 is measured with high precision by the laser interferometer 13 also when exchanging the reticles 9A and 9B in this example, What is necessary is to perform it only once, when the

above-mentioned reticle alignment loads these reticles 9A and 9B on the reticle stage 11 from an unillustrated reticle loader system, When exposing by exchanging the reticles 9A and 9B after it, it is also good to position the reticle stage 11 based on the measurement value of the laser interferometer 13.

On the other hand, the wafer 16 is held on the wafer stage 17 via an unillustrated wafer holder, and the wafer stage 17, Step moving of the wafer 16 is carried out in the direction of X, and the direction of Y on the surface plate 18, and the surface focusing position (position of a Z direction) and angle of inclination of the wafer 16 are doubled with the image surface of the projection optical system 14 by an autofocus system based on the measurement value of an unillustrated autofocus sensor. The two-dimensional position of the wafer stage 17 is measured by the moving mirror 19m and the laser interferometer 19, and the wafer stage drive system 22 controls operation of the wafer stage 17 based on this measurement value and the control information from the main control system 27. After exposure (or double exposure) of the reticle pattern image to one shot region on the wafer 16 finishes at the time of exposure,

operation that the next shot region is exposed by moving to an exposure position by the step moving of the wafer stage 17 is repeated by a step-and-repeat system. Thus, although it is a stepper type (one-shot exposure type), the projection aligner of this example does not have that this invention is applicable also until it says, also when using a scanning exposure type like a step and scanning method as a projection aligner. each shot region of the wafer 16 -- pile up -- in order to perform alignment at the time of exposure, it has the Image Processing Division type alignment sensor 25 by an off-axis system, and the imaging signal of the alignment sensor 25 is also supplied to the alignment signal processor 26. On the wafer stage 17, the reference mark component 20 in which the reference mark used when performing reticle alignment via the RA microscopes 8A and 8B, and the reference mark for alignment sensor 25 were formed is also installed.

Next, it explains per example of the operation at the time of exposing the image of a predetermined pattern using the projection aligner of this example. Although double exposure is performed in this example, exchanging two reticles to each shot region on the wafer 16, Expose all

the shot regions on the wafer 16 using the 1st reticle 9A of introduction, and a reticle is continuously exchanged for the 2nd reticle 9B, A throughput is higher than the direction which adopted the sequence which exposes all the shot regions on the wafer 16 again is exposed by exchanging the reticles 9A and 9B for every shot region. So, below, the operation which performs exposure to all the shot regions of a wafer continuously for every reticle is explained.

In [drawing 2 shows the figure to which the circuit pattern 31 of a certain layer of the electron device formed in each shot region of a wafer by this example was expanded selectively, and] this drawing 2, width dY2 [larger than it] (dY2 is about about 1.5 times of dY1) should lay on top of the both ends of the small-gage wire pattern P1a extended long and slender in the direction of X by width dY1 -- business -- the pattern P1c and the 1st gate pattern P1 of the form which has arranged P1d are formed. similarly, width dX2 [larger than it] (dX2 is about about 1.5 times of dX1) should lay on top of the end of the small-gage wire pattern P2a extended long and slender in the direction of Y by width dX1 -- business -- with the 2nd gate pattern P2 of the form which has arranged

the pattern P2c. At the end of the small-gage wire pattern P3a of width dX1 extended in the direction of Y, respectively, and the opposite hand of P3b. width dX2 [larger than it] should pile up -- business -- the pattern P3c, the gate pattern P3A of the form which has arranged P3d, and the 3rd gate pattern P3 that has arranged P3B by center interval eX1 (this example eX1=2anddX1) are formed. In this case, it is dX1=dY1.

Width dY1 (namely, dX1) of those isolated line small-gage wire patterns P1a, P2a, P3a, and P3b is the width about the resolution limit of the projection optical system 14 of the example of the book when not using deformation illumination, or width slightly thinner than this resolution limit.

The small-gage wire pattern P1a, P2a, P3a, and P3b support the linear pattern of this invention.

That is, when the numerical aperture of lambda and the projection optical system 14 is set to NA for an exposure wavelength, the resolution limits of the projection optical system 14 when not using deformation illumination are k1 and lambda/NA mostly using the predetermined process coefficient k1.

Width dY1 (dX1) is k1 and a lambda/NA grade, or a grade slightly thinner than this.

On the other hand, width dY2 (namely, dX2), such as the pattern P1c for superposition and P2c, is thickly set up about 1.5 times rather than its resolution limit k1 and lambda/NA.

The portions of the small-gage wire pattern P1a of the gate pattern P1, P2, and P3, P2a, P3a, and P3b are patterns which serve as a gate electrode of a field effect transistor, for example.

It is necessary to leave those gate patterns P1, P2, and P3, and to form on the layer concerned of each shot region of a wafer, as a pattern (pattern in which films, such as a metal membrane, remain only in the portion).

Although such tens of millions of or more gate patterns may be formed in the actual device, that electron device can be operated at high speed, so that this gate electrode is thin and that line width is fixed in all the parts of a device.

For formation of such a gate pattern P1, P2, and P3. The reticle which has the shielding pattern (original plate pattern) to which this and a formed similar figure were expanded is created, Although what is necessary is

just to carry out transfer exposure of the reduced image on a wafer with a projection aligner, it is difficult to maintain the proper depth of focus and to expose a pattern image thinner than the resolution limit about its k1 and lambda/NA with high precision, in the exposure method which does not use deformation illumination. So, in this example, from the original plate pattern to which the circuit pattern 31 of drawing 2 was expanded by the reciprocal (1/beta) twice of the projecting magnification beta of the projection optical system 14 of drawing 1, two reticle patterns are generated and these reticle patterns are independently formed in the reticles 9A and 9B of drawing 1. Although the length of a actual reticle pattern is the value which multiplied the desired value of the length on a wafer by twice (1/beta), below, it is displayed with the value of explanation for which the length of each part of a reticle pattern was converted into the length on a wafer for convenience. Although reversal projection is performed, for example, the projection optical system 14 of drawing 1 is explained as what is the direction with same reticle pattern and this projection image, in order to make it intelligible.

Drawing 3 (A) and (B) shows the reticle pattern drawn by the 1st reticle

9A and 2nd reticle 9B, respectively, The reticle pattern drawn by the 1st former reticle 9A forms the shielding pattern A1 which consists of a light-shielding film (it was made exact 1 / beta double) of the respectively same form as the gate patterns P1-P3 of drawing 2 - A3 into the transparent part 35. namely, the shielding pattern A1 -- the small-gage wire pattern P1a of drawing 2 -- and pile up -- business -- it consists of the pattern P1c, the pattern A1a of the respectively same form as P1d and A1c, and A1d. in this case, pile up the pattern A1c and A1d width -- business -- although it is the dY2 [same] as the pattern P1c and P1d width, the width of the central pattern A1a is expressed with dY3 to width dY1 of the small-gage wire pattern P1a.

This means that it may set up between 1 time - 2 times width dY1, although width dY3 of the pattern A1a corresponding to the small-gage wire pattern P1a may be the same as width dY1. Thus, line width is prevented from the line width of the image of the pattern A1a becoming narrow by exposure of the image near the resolution limit under the Lighting Sub-Division conditions which do not use deformation illumination, or becoming narrow by slight position gap of two reticle

patterns by setting up width dY3 of the pattern A1a widely. Even if it sets up width dY3 of the pattern A1a widely, since the final line width of the image of the pattern A1a is prescribed by exposure of the pattern image of the 2nd reticle 9B, it is satisfactory.

the same -- the shielding pattern A2 -- the small-gage wire pattern P2a of drawing 2 -- and pile up -- business -- it consists of the pattern A2a of width dX3 (=dY3) of the respectively same form as the pattern P2c, and the pattern A2c of width dX2. shielding pattern A3 -- the small-gage wire pattern P3a of drawing 2 -- and pile up -- business -- with 1st shielding pattern A3A that consists of pattern A3a and A3c of the same form as the pattern P3c. the small-gage wire pattern P3b -- and pile up -- business -- it comprises the 2nd shielding pattern A3B that consists of pattern A3b and A3d of the same form as the pattern P3d.

The center interval of pattern A3a of width dX3 and A3b is the same as center interval eX1 of the small-gage wire pattern P3a and P3b.

Next, the pattern drawn by the 2nd reticle 9B of drawing 3 (B), Two or more transmission patterns B1, B-2, and B3 are arranged in a prescribed

direction, respectively in the position equivalent to the small-gage wire pattern P1a of drawing 2, the small-gage wire pattern P2a and the small-gage wire pattern P3a, and the original plate pattern of P3b, and let the other field be the shade part 32. and the 1st transmission pattern B1 puts long and slender original plate pattern P1a' in the direction of X which shows the small-gage wire pattern P1a of drawing 2 by the dotted line in which projecting magnification carried out reciprocal (1/beta) double correctly (it touches) -- like, the width of the same form as original plate pattern P1a' -- about -- the transmission pattern which is four of dY1 -- the direction of Y -- about (in namely, direction which intersects perpendicularly with the long side direction (longitudinal direction) of original plate pattern P1a') -- it is a pattern arranged in the pitch of 2 and dY1.

2nd transmission pattern B-2 puts long and slender original plate pattern P2a' in the direction of Y of the small-gage wire pattern P2a of drawing 2 (it touches) -- like -- the width of the same form as original plate pattern P2a' -- about -- the transmission pattern which is four of dX1 -- the direction of X -- about -- it is a pattern arranged in the pitch of 2 and dX1.

the same -- the -- three -- a transmission pattern -- B -- three -- drawing 2 -- a small-gage wire -- a pattern -- P -- three -- a -- P -- three -- b -- an original plate pattern -- P -- three -- a -- ' -- P -- three -- b -- ' -- putting (it touches) -- like, The width of the same form as original plate pattern P3a' is a pattern which has arranged mostly the transmission pattern which is six of dX1 mostly in the pitch of 2 and dX1 in the direction of X. As the transmission pattern B1 and B-2, the pattern which has arranged periodically two pieces - about eight rectangular transmission patterns, respectively can be used. Similarly, as the transmission pattern B3, the pattern which has arranged periodically three pieces - about nine rectangular transmission patterns, respectively can be used.

The long side direction of the original plate pattern of each small-gage wire pattern P1 a-P 3a and P3b in which the long side direction of each transmission patterns B1-B3 corresponds so that drawing 3 (B) may show (Y directions) Or it is in agreement with the direction of X, and the long side direction of each corresponding small-gage wire pattern and the period directions of each transmission patterns B1-B3 aim to cross at right angles. furthermore -- drawing 2 -- each -- a small-gage wire -- a

pattern -- P -- one -- a-P -- three -- a -- P -- three -- b -- an original plate pattern -- P -- one -- a -- ' - P -- three -- a -- ' -- P -- three -- b -- ' -- corresponding -- a portion -- respectively -- a shielding pattern -- becoming -- **** . And on the occasion of synthetic exposure, the physical relationship of each shielding pattern A1 contained in the 1st reticle 9A - A3, and each transmission patterns B1-B3 contained in the 2nd reticle 9B is arranged so that it may overlap correctly. Therefore, although not illustrated, one pair of alignment marks are formed in the pattern space of the reticles 9A and 9B with the predetermined interval in the direction of X, respectively.

Next, with reference to the flow chart of drawing 7, it explains per exposure operation of this example. First, in Step 101 of drawing 7, the photoresist of a positive type is applied to the wafer of one lot. The predetermined circuit pattern is formed in the layer of the ground of each shot region of the wafer of the one lot at the process till then, respectively. Then, the wafer of the one lot is conveyed by the wafer cassette which is not illustrated near the projection aligner of drawing 1. Next, one wafer in the one lot is loaded on the wafer stage 17 of drawing 1, and wafer

alignment is performed via the alignment sensor 25 (Step 102). Then, the reticle stage 11 is driven, the 1st reticle 9A is moved to the illuminated field by illumination-light IL2, and reticle alignment is performed using the RA microscopes 8A and 8B or the laser interferometer 13 (Step 103). In Step 104 following it, Lighting Sub-Division conditions are optimized to the reticles 9A by installing sigma diaphragm which rotates the rotor plate 42 and corresponds in the projection surface 5 of the fly eye lens 41. Since the shielding pattern A1 - A3 of drawing 3 (A) drawn by this reticle 9A have low periodicity, it is not necessary to use deformation illumination in particular, and the sigma diaphragm 45 with the circular opening 45a shown in drawing 5 (C) is installed in that projection surface 5. The KOHI reference factor (sigma value) of the opening 45a is about 0.3 to 0.7 usual circular opening, for example. The Lighting Sub-Division conditions which use the sigma diaphragm 45 are called "being usually Lighting Sub-Division" here. However, a diaphragm of other form may be used if needed. Under the Lighting Sub-Division condition, projection exposure of the pattern image of the reticle 9A is carried out to each shot region of a wafer.

Next, in Step 105, the reticle stage 11 is driven, the 2nd reticle 9B is moved to an illuminated field, and reticle alignment is performed. In subsequent Step 106, Lighting Sub-Division conditions are optimized to the periodic transmission patterns B1-B3 of the reticle 9B of drawing 3 (B). In this case, in order to consider it as the suitable deformation illumination for formation of the pattern which has periodicity in the 2-way (the direction of X, the direction of Y) which intersects perpendicularly, the sigma diaphragm 44 which has the four openings 44a-44d shown in drawing 5 (B) is set as the projection surface 5. The direction of X and the direction of Y in drawing 5 (B) - (E) aim to correspond in the direction of X and the direction of Y of [on the wafer stage 17 of drawing 1], respectively. The openings 44a-44d of the sigma diaphragm 44 focusing on optic-axis AX1 The period directions of the transmission pattern B1 of drawing 3 (B) (the direction of Y), and in accordance with transmission pattern B-2 and four directions which it rotated 45 degrees at a time to the period directions (the direction of X) of B3, respectively, it centered on the equidistant position from optic-axis AX1 -- small -- it is circular. If such sigma diaphragm 44 is used, can improve the resolution and the

depth of focus of a pattern which have periodicity in the direction of X, and the direction of Y, but. Since the principle is expressed to Japan JP,H5-206007,A and US,5719704,B in detail, omit explanation here, but. As long as the national law of the designated state which specified by application at the its native country time, or the selected elected State allows, the indication of the above-mentioned gazette and an United States patent is used, and it is made a part of description of the text. Since the projection surface 5 where the sigma diaphragm 44 is arranged is an optical Fourier transformation plane to the pattern surface side of the reticle 9B as above-mentioned, the projection surface 5 has an arrangement surface of the aperture diaphragm 15 within the projection optical system 14, and conjugate (image formation relations). And an openings [of the sigma diaphragm 44 of drawing 5 (B) / 44a-44d] image, Consider it as the position in the opening of the corresponding aperture diaphragm 15 which is separated from an optic axis as much as possible so that it may be located as much as possible in a periphery, and. By making each with a frontages [the / 44a-44d] inside diameter as small as possible, it becomes possible to transfer the image of the transmission

patterns B1-B3 corresponding to the much more detailed linear pattern P1a, P2a, P3a, and P3b with high precision.

However, the deformation illumination which will be used if the line width of the linear pattern which should be transferred is thicker than a 0.4x lambda/NA grade to the exposure wavelength lambda and the numerical aperture NA of a projection optical system, as mentioned above, it separating from an optic axis as much as possible, and in an illumination-light study system pupil surface, It is not limited to the deformation illumination using the smallest possible opening, but near the optic axis, the intensity distribution of the illumination light in an illumination-light study system pupil surface is weak, and can also use deformation illumination with comparatively weak degree of concentration which becomes strong in portions other than this (this outside). Zona-orbicularis Lighting Sub-Division can also be used. Of course, when the line width of the linear pattern which should be transferred is thinner than a 0.4x lambda/NA grade, it is desirable to separate from an optic axis as much as possible, and to use the deformation illumination using the smallest possible opening in the

illumination-light study system pupil surface like the above.

Under the deformation illumination, projection exposure of the pattern image of the reticle 9B is carried out to each shot region of a wafer. And Steps 102-106 are repeated and synthetic exposure (double exposure) of the image of the reticles 9A and 9B of two sheets is carried out to all the wafers of one lot, respectively until an unexposed wafer is lost at Step 107. By the way, the image formation light flux which usually penetrated the reticle when deformation illumination was used, It will pass, after having been condensed by the specified part within a projection optical system, and the projection optical system is locally heated by absorption of the image formation light flux in the process in which it exposes for a long time, local modification and refractive index change arise, and there is a possibility that an imaging characteristic may deteriorate. However, the 2nd reticle 9B used when performing deformation illumination in this example, Let all the other portions only by only having the periodic transmission pattern B1, B-2, and B3 be the shade parts 32 only near the portion equivalent to the linear pattern P1a which should be transferred, P2a, P3a, and P3b. Therefore, the light volume of the image formation

light flux which most illumination luminous flux is shaded by the reticle 9B, and penetrates the inside of the projection optical system 14 is slight, and there is no possibility that degradation of the imaging characteristic like the above may arise.

The image of the pattern of the two reticles 9A and 9B is recorded on the photoresist on each shot region of each wafer in logical sum about each of above-mentioned wafers by two exposure. That is, the photoresist of the field which was a bright section (transmission pattern) in one of exposure at least exposes, and the photoresist of the field which was dark space (shielding pattern) twice has not exposed.

Next, it shifts to Step 108 and the wafer of one lot after double exposure is developed. Since the photoresist of this example is a positive type, after development, only an unexposed portion carries out a residual membrane, and, as a result, the portion corresponding to the gate pattern P1 of drawing 2, P2, and P3 is formed as a resist pattern. In this case, in it and the corresponding reticle 9A, since fields other than the portion corresponding to the gate pattern P1 which should be transferred, P2, and P3 serve as the transparent part 35, there is nothing of many 32

shade part which exists in the reticle 9B that a resist does for a residual membrane (incorrect-transferred).

In the exposure which uses the 2nd reticle 9B by this example compared with the method of exposing synthetic exposure of this example by 1 time like before, i.e., the exposure method which uses only the 1st reticle 9A substantially, It is possible to raise remarkably the resolution and the depth of focus of the small-gage wire pattern P1a in the gate pattern P1, P2, and P3, P2a, P3a, and P3b. Therefore, this feature is harnessed after synthetic exposure and improvement in the resolution of the image of the small-gage wire pattern P1a, P2a, P3a, and P3b and the depth of focus is attained. Each light exposure in two above-mentioned exposure may not be by equal divisions of the amount of appropriate exposure defined from the sensitivity of photoresist, i.e., the half, and if it sets up more light exposures at the time of the exposure using the reticle 9B, it is much more effective.

Then, in the work process of Step 109, the gate pattern of drawing 2 is formed in the layer concerned by performing etching etc. by using as a mask the resist pattern left behind after development to the wafer of one

lot. Then, after passing through the resist removal process etc. which remove the unnecessary resist after a work process, a wafer process is completed by the thing of a wafer for which each process, such as a resist application, exposure, development, processing, and resist removal, is further repeated successively to the upper layer. An end of a wafer process will manufacture a semiconductor device eventually in a actual assembly process through the printed dicing process which cuts and carries out chip making of the wafer for every circuit, the bonding process which performs wiring etc. for each chip, the packaging process which carries out packaging for every chip, etc.

Next, with reference to drawing 3 - drawing 5, it explains per other examples of an embodiment of the invention.

Drawing 4 (A) and (B) shows the 2nd reticle 9C used by this example instead of and the 3rd reticle 9D, respectively. [the 2nd reticle 9B of drawing 3 (B)] In this example, Mie exposure (synthetic exposure) is carried out, carrying out alignment of the pattern image of the reticle 9A of drawing 3 (A), and the reticles 9C and 9D of two sheets of drawing 4 one by one, and the gate patterns P1-P3 of drawing 2 are formed.

As shown in drawing 4 (A), only the periodic transmission pattern B1 which is a pattern which has periodicity in the direction of Y among the patterns drawn by the reticle 9B of drawing 3 (B) is drawn by the reticle 9C. As shown in drawing 4 (B), only periodic transmission pattern B-2 which is a pattern which has periodicity in the direction of X among the patterns drawn by the reticle 9B, and B3 are drawn by the reticle 9D. And as for both the reticles 9C and 9D, portions other than the transmission pattern are the shade parts 33 and 34.

Thus, the period directions of a periodic transmission pattern face exposure of the reticles 9C and 9D limited only in the direction of Y, and the direction of X, If the deformation illumination which installs the sigma diaphragms 46 and 47 with two openings as shown in drawing 5 (D) and (E), respectively in the projection surface 5 of the fly eye lens 41 of drawing 1 is used as the Lighting Sub-Division condition, improvement in much more resolution and the depth of focus is possible. This principle is also stated to above-mentioned Japan JP,H4-101148,A in detail.

That is, it is preferred to use the sigma diaphragm 46 which has the openings 46a and 46b for two places which are [the equal distance]

distant from optic-axis AX1 on the Y-axis (straight line of the direction of Y which passes along optic-axis AX1 of an illumination-light study system) of drawing 5 (D) when exposing the reticle 9C which has the transmission pattern B1 which has periodicity in the direction of Y. It is preferred to use the sigma diaphragm 47 which has the openings 47a and 47b for two places which are [the equal distance] distant from optic-axis AX1 on the X-axis (straight line of the direction of X which passes along optic-axis AX1 of an illumination-light study system) of drawing 5 (E) on the other hand when exposing transmission pattern B-2 which has periodicity, and the reticle 9D which has B3 in the direction of X.

In this example, since the transmission pattern B1 and transmission pattern B-2 differ from the Lighting Sub-Division conditions optimal at B3, Mie exposure of the wafer shall be carried out using the reticles 9A, 9C, and 9D of three sheets, but it may be made to perform Mie exposure using the reticles 9A and 9B of two sheets used by the above-mentioned embodiment. Namely, so that illumination-light IL2 may be irradiated by only the predetermined region containing the transmission pattern B1 on the reticle 9B, before performing exposure by the reticle 9B to the wafer

in which exposure by the reticle 9A was performed, The illuminated field by illumination-light IL2 on the reticle 9B is adjusted with the field diaphragm (reticle blind) arranged within an illumination-light study system in the pattern surface side of a reticle, and an almost conjugate field. This is performed, for example in parallel to exchange of sigma diaphragm. And the transmission pattern B1 is irradiated with illumination-light IL2 through the sigma diaphragm 46, and the image of the transmission pattern B1 is transferred in piles in the image of the shielding pattern A1 on the wafer W. Next, sigma diaphragm is exchanged, while adjusting the illuminated field on the reticle 9B with a field diaphragm so that illumination-light IL may be irradiated by only transmission pattern B-2 and the predetermined region containing B3. After an appropriate time, transmission pattern B-2 and B3 are irradiated with illumination-light IL2 through the sigma diaphragm 47, and transmission pattern B-2 and the image of B3 are transferred in piles in the image of the shielding pattern A2 and A3. The transfer image can be formed on a wafer on the optimal Lighting Sub-Division conditions for one or more transmission patterns of every, without exchanging reticles, even

if several transmission patterns in which the optimal Lighting Sub-Division conditions differ by this are intermingled on the reticle 9B.

Although a wafer is exposed using the reticle 9A, the reticle 9B (or reticles 9C and 9D) shall be used for after an appropriate time and a wafer shall be exposed in the above-mentioned embodiment, reverse may be sufficient as the order. That is, a use order of two or more reticles used for multiple exposure may be arbitrary.

In the above-mentioned embodiment, when the inside diameter of the small circular openings 44a-44d and 46a, 46b, 47a, and 47b of the sigma diaphragms 44, 46, and 47 for deformation illuminations is small like the above, as the illuminance distribution plastic surgery optical system 4, If the combination of the fly eye lens 41 and sigma diaphragm as shown in drawing 1 is used, the efficiency (transmissivity) of the illumination light which penetrates each small aperture of sigma diaphragm for deformation illuminations will fall greatly. In order to avoid this, the optical system which combined a light flux division system which is indicated by Japan JP,H5-206007,A, the condensing optical system, and the illumination equalization optical system, for example may be used. A

glass rod can also be used as an illumination equalization optical system (optical integrator). The axicon of a couple can be used as a light flux division system, the interval of the axicon of the couple can be adjusted for the luminous energy distribution of illumination-light IL2 on the Fourier transformation plane in an illumination-light study system well also as the shape of zona orbicularis, and the size can also be changed. If the sigma diaphragm 44 shown in drawing 5 (B) is used together at this time, compared with the combination of the fly eye lens 41 and the sigma diaphragm 44 which were mentioned above, a light volume loss can be suppressed small. As mentioned above, what kind of composition may be sufficient as the mechanism in which the luminous energy distribution (form and a size at least on the other hand) of illumination-light IL2 on the Fourier transformation plane within Lighting Sub-Division conditions, i.e., an illumination-light study system, is changed?

In an above embodiment, although all reticle patterns shall consist of a transparent part and a shade part, The reticle pattern made into the dimmed type (half-tone type) phase shift part which shifts 180 degrees of phases of the transmitted light to a transparent part, and makes

transmissivity about 3 to 10% instead of a shade part may be adopted. In this case, the resolution of cyclic patterns as shown in the reticles 9B, 9C, and 9D can be raised further. At this time, deformation illumination (zona-orbicularis Lighting Sub-Division is included) is put together and used.

However, if all (non-pattern part) of the shade part of the reticles 9B, 9C, and 9D are made into a dimmed type phase shift part, the end of the small-gage wire pattern in the gate pattern P1 shown in drawing 2, P2, and P3 should pile up -- business -- the portion corresponding to the pattern P1c, P1d, P2c, P3c, and P3d will be slightly exposed by the transmitted light from the dimmed type phase shift part. However, although it is small with a dimming operation of a dimmed type phase shift part, when it poses a problem, the reticle 9E shown in drawing 6 may be used for the light exposure instead of the reticles 9B, 9C, and 9D. The pattern of the reticle 9E of drawing 6 constitutes only each periodic transmission pattern part from the transparent part 91, constitutes only the meantime from the dimmed type phase shift part 92, and constitutes the other portion from the shade part 93. if this reticle pattern is used, the

above should pile up -- business -- the adverse effect to portions, such as the pattern P1c, P1d, P2c, P3c, and P3d, can be prevented thoroughly. As indicated by Japan JP,H5-13305,A and corresponding US,5343270,B, Japan JP,H4-277612,A, and corresponding US,5194893,B, for example, While exposing one shot region on a wafer using the reticle 9A, it may be made to move a wafer to a Z direction parallel to optic-axis AX2 of the projection optical system 14. As it uses together with this method, or is independent and is indicated by Japan JP,H4-179958,A and corresponding US,5552856,B, for example, It may be made to use the light filter which shades the illumination light distributed in the circular area centering on the optic axis on the Fourier transformation plane (pupil surface) within the projection optical system 14, and what is called a pupil filter. As long as the national law of the designated state which specified by application at the its native country time, or the selected elected State allows, the indication of the gazette of the three above-mentioned affairs and the United States patent of three affairs is used, and it is made a part of description of the text. sigma diaphragm which has a circular opening which does not adopt deformation illumination (zona-orbicularis Lighting

Sub-Division is included) in this case respectively well as a spatial frequency abnormal-conditions type phase shift reticle but, from which a coherence factor (sigma value) becomes 0.1 to about 0.4 about the reticles 9B-9D, for example is used -- Lighting Sub-Division is usually adopted.

In an above embodiment, although the long side direction of the pattern which needs resolution is limited in the direction of X, or the direction of Y, the long side direction may be the arbitrary directions of [other than the direction of X and the direction of Y]. It is good also considering two patterns in which the long side direction crosses angles other than 90 degree mutually, for example as an exposure object. It is desirable to also change the reticles 9B and 9C, the period directions of the transmission pattern of each periodicity in 9D, and the conditions of deformation illumination in the direction which intersects perpendicularly with the long side direction in these cases according to it. For example, a long side direction may improve at least three patterns which cross mutually the business which adopts zona-orbicularis Lighting Sub-Division in this case also as an exposure object.

Although the pattern which carries out multiple exposure is drawn by mutually different reticle in the above-mentioned embodiment, The pattern which carries out multiple exposure is drawn to the field to which the pattern surface sides of the reticle of one sheet differ, the pattern which should be exposed by a field diaphragm at the time of exposure is specified, and it moves in a wafer stage and may be made to perform alignment.

Although the gate pattern is assumed in the above-mentioned embodiment as an example of the pattern which applies this invention, this invention is applicable to other natural pattern and other processes.

In using far ultraviolet rays, such as excimer laser, as illumination light for exposure, it uses the material which penetrates the far ultraviolet ray of quartz (SiO_2), fluorite (CaF_2), etc. as ** material of a projection optical system. Any of refractive media, a reflection system, and reflective refractive media may be sufficient as a projection optical system.

The single wavelength laser of an infrared region or a visible range oscillated from a DFB semiconductor laser or fiber laser, For example, the harmonics which were amplified with the fiber amplifier with which

erbium (Er) (or both erbium and an ytterbium (Yb)) was doped, and carried out wavelength changing to ultraviolet radiation using the nonlinear optical crystal may be used as illumination light for exposure. The luminescent line generated, for example from a mercury lamp (for example, g line, i line, etc.), Or the soft-X-ray field of 13.4 nm generated from the source of laser excitation plasma light or SOR (wavelength of about 5-50 nm), for example, wavelength, and 11.5-nm EUV (Extreme Ultra Violet) light may be used as illumination light for exposure. That is, the wavelength of the illumination light for exposure used with the projection aligner with which this invention is applied may be arbitrary. In the exposure device using EUV light, a reflection type reticle is used and a projection optical system consists only of a reflected-light study element (mirror) which is about two or more sheets, for example, 3-8 sheets. This invention is applicable also to the scanning projection aligner indicated by Japan JP,H4-196513,A and corresponding US,5473410,B, for example as mentioned above, As long as the national law of the designated state which specified by application at the its native country time, or the selected elected State allows, the indication of the above-mentioned

gazette and an United States patent is used, and it is made a part of description of the text.

And include an illumination-light study system including the illuminance distribution plastic surgery optical system 4 of this example, and a projection optical system in the main part of a projection aligner, and carry out optical adjustment, and. The projection aligner of this embodiment can be manufactured by attaching to the main part of a projection aligner the reticle stage and wafer stage which consist of many machine parts, and connecting wiring and piping, and also carrying out comprehensive adjustments (electric adjustment, operation confirming, etc.). As for manufacture of a projection aligner, it is desirable to carry out in the clean room where temperature, an air cleanliness class, etc. were managed.

It can apply also to the projection aligner for the liquid crystals which expose a liquid crystal display element pattern to a square-shaped glass plate, and the projection aligner for manufacturing a thin film magnetic head widely, for example, without being limited to the projection aligner for semiconductor manufacture as a use of a projection aligner. This

invention is applicable also to the reduced-projection-exposure equipment of the step and SUTITCHI system which is used for manufacture of a photo mask or a reticle, for example, uses far ultraviolet light or vacuum ultraviolet light as illumination light for exposure.

Thus, this invention is not limited to an above-mentioned embodiment, but can take various composition in the range which does not deviate from the summary of this invention. All the disclosure of the Japan patent application No. 161896 [ten to] of the presentation dated June 10, 1998 including a Description, Claims, Drawings, and a summary is quoted as they are just as it is, and is incorporated here.

Possibility of industrial use The 1st mask pattern in which the pattern which should be transferred was formed according to the 1st transfer method of this invention, Since synthetic exposure is performed using the 2nd mask pattern that used the portion corresponding to a linear pattern as the periodic transmission pattern, there is an advantage which can expose the image of a circuit pattern which consists of a linear pattern and a wide pattern of this end like a gate pattern with high precision.

In the 2nd mask pattern that performs deformation illumination, fields

other than the transmission pattern are made into a dimming part, and since there is little light volume of the image formation light flux which passes a projection optical system, when using deformation illumination for a part of Lighting Sub-Division conditions, degradation of the imaging characteristic of a projection optical system can be controlled.

Next, according to the 2nd and 3rd transfer methods of this invention, the image of a pattern like an isolated line can be transferred with high precision.

According to the exposure device of this invention, such an exposure method can be used, and, according to the manufacturing method of the device of this invention, there is an advantage which can manufacture a device with high precision using such an exposure method.

[Brief Description of the Drawings]

Drawing 1 is a block diagram showing the projection aligner used with an example of an embodiment of the invention. Drawing 2 is a figure in which expanding selectively an example of the circuit pattern of a certain layer of the device formed by the embodiment, and showing it. Drawing 3 is a figure showing the pattern constitution of the reticle of two sheets

used in order to project the image of the circuit pattern of drawing 2. The figure showing the pattern of the 2nd reticle in which drawing 4 (A) is used in other examples of an embodiment of the invention, and drawing 4 (B) are the figures showing the 3rd reticle used by the embodiment. The sectional view which meets AA line of drawing 5 (B) in which the state where the sigma diaphragm 44 has been arranged to the projection surface of the fly eye lens 41 of drawing 1 is shown, and drawing 5 (B) drawing 5 (A), The figure, drawing 5 (D), and drawing 5 (E) in which the sigma diaphragm 45 in which the figure showing the sigma diaphragm 44 for deformation illuminations and drawing 5 (C) have a circular opening is shown are a figure showing the sigma diaphragms 46 and 47 for deformation illuminations, respectively. Drawing 6 is a figure showing the reticle which constituted only the periodic transmission pattern from a transparent part, constituted only the meantime from a dimmed type phase shift part, and constituted the other portion from a shade part. Drawing 7 is a flow chart which shows the exposure operation of an example of an embodiment of the invention.

WRITTEN AMENDMENT

[Written Amendment] Written Submission of Copy of Amendment under Article 34 of the Patent Cooperation Treaty

[Filing date]Heisei 12(2000) April 20 (2000.4.20)

[Amendment 1]

[Document to be Amended]Description

[Item(s) to be Amended]Claims

[Method of Amendment]Change

[The contents of amendment]

[Claim(s)]

[Claim 1](After amendment) A linear pattern and this linear pattern are transfer methods which transfer on a substrate an image of a pattern of prescribed shape constituted with a different pattern of form via a projection optical system,

A transfer method comprising:

The 1st mask pattern with form corresponding to a pattern of said prescribed shape.

A process of transferring in piles said linear pattern and the 2nd mask pattern arranged to the cross direction of a pre-wiring-like pattern periodically [two or more straight line patterns which have comparable line width substantially] on said substrate.

[Claim 2](After amendment) It is a transfer method which transfers on a substrate an image of a gate pattern which comprises a linear pattern with specified width, and an end pattern which it is provided in an end of said linear pattern, and has width wider than said specified width via a projection optical system,

A transfer method comprising:

The 1st mask pattern with form corresponding to said gate pattern.

A process of transferring in piles the 2nd mask pattern with a pattern which does not exist as said gate pattern on said substrate.

[Claim 3](After amendment) It is a transfer method which transfers on a substrate an image of a gate pattern which comprises a linear pattern with specified width, and an end pattern which it is provided in an end of

said linear pattern, and has width wider than said specified width via a projection optical system,

A transfer method comprising:

The 1st mask pattern with form corresponding to said gate pattern.

A process of transferring in piles the 2nd mask pattern that has periodicity in a prescribed direction on said substrate.

[Claim 4](After amendment) It is a transfer method which transfers on a substrate an image of a gate pattern which comprises a linear pattern with specified width, and an end pattern which it is provided in an end of said linear pattern, and has width wider than said specified width via a projection optical system,

A transfer method including a process of transferring in piles the 1st mask pattern containing form corresponding to said gate pattern, and the 2nd mask pattern containing a pattern denser than said 1st mask pattern on said substrate.

[Claim 5](After amendment) Lighting Sub-Division conditions at the time of transferring an image of said 2nd mask pattern, A transfer method of

Claim 1 description considering it as deformation illumination in a field of the outside in which intensity distribution in an optical Fourier transformation plane to a pattern of a transfer object of an illumination-light study system is more powerful than a field including an optic axis of said illumination-light study system.

[Claim 6](After amendment) A portion corresponding to said prescribed pattern in said 1st mask pattern is made into a dimming part, and let other portions be transparent parts,

Said straight line patterns are arranged as a transmission pattern so that a portion corresponding to said linear pattern may be touched, and said 2nd mask pattern. Claim 1, wherein fields other than said straight line patterns near the portion corresponding to said linear pattern are made into a dimming part at least, or a transfer method given in 5.

[Claim 7](After amendment) When said linear pattern is used as the 1st linear pattern, a pattern of said prescribed shape contains further the 2nd linear pattern that makes a direction which intersects perpendicularly with a long side direction of said 1st linear pattern a long side direction,

Said 2nd mask pattern has line width substantially comparable as said

2nd linear pattern respectively, and contains further two or more transmission patterns arranged periodically crosswise [of this linear pattern] so that a portion corresponding to said 2nd linear pattern may be touched,

Conditions of said deformation illumination at the time of transferring an image of said 2nd mask pattern, Intensity distribution of illumination light in said optical Fourier transformation plane, A transfer method of Claim 5 description becoming distribution centering on four positions which met in the direction rotated 45 degrees substantially, respectively from a direction corresponding to a long side direction of said 1st and 2nd linear patterns centering on said optic axis.

[Claim 8](After amendment) A transfer method of Claim 7 description setting up more greatly than a light exposure when transferring said 1st mask pattern a light exposure when transferring said 2nd mask pattern.

[Claim 9](After amendment) When said linear pattern is used as the 1st linear pattern, a pattern of said prescribed shape contains further the 2nd linear pattern that makes a direction which intersects a long side direction of said 1st linear pattern a long side direction,

Two or more transmission patterns which have line width substantially comparable as said 2nd linear pattern respectively are periodically arranged crosswise [of said 2nd linear pattern] so that a portion corresponding to said 2nd linear pattern may be touched, And fields other than said transmission pattern near the portion corresponding to said 2nd linear pattern use further at least the 3rd mask pattern made into a dimming part,

While carrying out alignment of the image of said three mask patterns mutually and transferring it one by one on said substrate via said projection optical system,

Lighting Sub-Division conditions at the time of transferring an image of said 2nd mask pattern, and an image of said 3rd mask pattern, A direction to which a long side direction of said 1st linear pattern and intensity distribution of illumination light in said optical Fourier transformation plane cross at right angles, respectively, And a transfer method of Claim 5 description considering it as deformation illumination used as distribution centering on two positions which are separated from said optic axis in the direction corresponding to a direction which intersects perpendicularly

with a long side direction of said 2nd linear pattern.

[Claim 10](After amendment) A transfer method of Claim 9 description setting up more greatly than a light exposure when transferring said 1st mask pattern a light exposure when transferring said 2nd mask pattern.

[Claim 11](After amendment) A transfer method of Claim 1-4, wherein line width of a portion corresponding to said linear pattern in said 1st mask pattern is 1 time - twice the line width of said linear pattern given in any 1 clause.

[Claim 12](After amendment) A transfer method of Claim 1-4 changing an exposing condition of said substrate when transferring said 1st mask pattern, and an exposing condition of said substrate when transferring said 2nd mask pattern given in any 1 clause.

[Claim 13](After amendment) A transfer method of Claim 12 description, wherein said exposing condition includes intensity distribution of said illumination light on an optical Fourier transformation plane to said mask pattern in an illumination-light study system which irradiates said 1st and 2nd mask patterns with illumination light, respectively.

[Claim 14](After amendment) A transfer method of Claim 13 description

raising intensity distribution of said illumination light in a field of the outside on said Fourier transformation plane rather than a field including an optical axis of said illumination-light study system when transferring an image of said 2nd mask pattern.

[Claim 15](After amendment) A transfer method of Claim 12 description, wherein said exposing condition contains a light exposure of said substrate when transferring said mask pattern.

[Claim 16](After amendment) A transfer method of Claim 15 description making a light exposure when transferring said 2nd mask pattern larger than a light exposure when transferring said 1st mask pattern.

[Claim 17](After amendment) A transfer method of Claim 1-5, wherein said 2nd mask pattern contains a translucent section to which about 180 degrees of phases of illumination light irradiated by this mask pattern are shifted given in any 1 clause.

[Claim 18](After amendment) Said 1st and 2nd mask patterns are formed in a mutually different mask, and said two masks, Claim 1 and 3 characterized by being arranged one by one at the object face side of said projection optical system so that a longitudinal direction of a portion

corresponding to said linear pattern and period directions of said 2nd mask pattern may intersect perpendicularly among said 1st mask pattern, or a transfer method given in five.

[Claim 19]Two or more said 1st mask pattern adjoins, and has straight line patterns of form corresponding to said linear pattern,

A transfer method of Claim 1-5 adjoining on said substrate and forming two or more gate patterns provided with said linear pattern by transferring said 1st mask pattern on said substrate given in any 1 clause.

[Claim 20](Addition) A device manufacturing method including Claim 1-5 and a process of transferring an image of said mask pattern on said substrate using a transfer method of 7-10 given in any 1 clause.

[Claim 21](Addition) A device manufacturing method including a process of transferring an image of said mask pattern on said substrate using a transfer method of Claim 14 description.

[A Written Amendment]

[Filing date]Heisei 12(2000) November 14 (2000.11.14)

[Amendment 1]

[Document to be Amended]Description

[Item(s) to be Amended]Claims

[Method of Amendment]Change

[The contents of amendment]

[Claim(s)]

[Claim 1]It is a transfer method which transfers on a substrate an image of a gate pattern which comprises an end pattern which is provided in an end of a linear pattern with specified width, and said linear pattern, and has width wider than said specified width via a projection optical system,

A process of transferring in piles the 1st mask pattern with form corresponding to said gate pattern and the 2nd mask pattern with a pattern which does not exist as said gate pattern on said substrate, respectively is included,

A transfer method changing the 1st exposing condition when transferring said 1st mask pattern on said substrate, and the 2nd exposing condition when transferring said 2nd mask pattern on said substrate.

[Claim 2]It is a transfer method which transfers on a substrate an image of a gate pattern which comprises an end pattern which is provided in an end of a linear pattern with specified width, and said linear pattern, and

has width wider than said specified width via a projection optical system,

A process of transferring in piles the 1st mask pattern with form corresponding to said gate pattern, and said linear pattern and the 2nd mask pattern in which two or more straight line patterns which have comparable line width substantially were arranged periodically crosswise [of said linear pattern] on said substrate, respectively is included,

A transfer method changing the 1st exposing condition when transferring said 1st mask pattern on said substrate, and the 2nd exposing condition when transferring said 2nd mask pattern on said substrate.

[Claim 3]It is a transfer method which transfers on a substrate an image of a gate pattern which comprises an end pattern which is provided in an end of a linear pattern with specified width, and said linear pattern, and has width wider than said specified width via a projection optical system,

A process of transferring in piles the 1st mask pattern with form corresponding to said gate pattern and the 2nd mask pattern containing a pattern denser than said 1st mask pattern on said substrate, respectively is included,

A transfer method changing the 1st exposing condition when transferring

said 1st mask pattern on said substrate, and the 2nd exposing condition when transferring said 2nd mask pattern on said substrate.

[Claim 4]A portion of form corresponding to said gate pattern in said 1st mask pattern is made into a dimming part, and let other portions be transparent parts,

Straight line patterns are arranged as a transmission pattern so that a portion corresponding to said linear pattern may be touched, and said 2nd mask pattern. A transfer method given in Claim 1, wherein fields other than said straight line patterns near the portion corresponding to said linear pattern are made into a dimming part at least, 2, or 3.

[Claim 5]The transfer method according to any one of claims 1 to 4, wherein line width of a portion corresponding to a gate electrode in said 1st mask pattern is 1 time - twice the line width of said linear pattern.

[Claim 6]The transfer method according to any one of claims 1 to 5, wherein said 1st and 2nd exposing conditions include intensity distribution of said illumination light on an optical Fourier transformation plane to said mask pattern in an illumination-light study system which irradiates said 1st and 2nd mask patterns with illumination light,

respectively.

[Claim 7]Said 1st exposing condition includes usual Lighting Sub-Division conditions which raise intensity distribution of illumination light in a field including an optic axis of said illumination-light study system on said optical Fourier transformation plane rather than intensity distribution of said illumination light in a field of the outside,

The transfer method according to claim 6, wherein said 2nd exposing condition includes deformation illumination conditions which raise intensity distribution of said illumination light in a field of the outside on said optical Fourier transformation plane rather than a field including an optic axis of said illumination-light study system.

[Claim 8]The transfer method comprising according to claim 7:

The 1st deformation illumination conditions which raise intensity distribution of said illumination light [conditions / said / deformation illumination] on said optical Fourier transformation plane in a zona-orbicularis-like field.

inside with the 2nd deformation illumination conditions which raise two or more positions arranged outside said optic axis in said intensity

distribution in two or more central local domains, respectively -- at least -- on the other hand.

[Claim 9]Said gate pattern contains the 1st gate pattern containing the 1st linear pattern and the 2nd gate pattern containing the 2nd linear pattern that makes a longitudinal direction a direction which intersects perpendicularly with a long side direction of said 1st linear pattern,

Said 1st mask pattern contains a pattern which has the form corresponding to said 1st and 2nd gate patterns, respectively,

Two or more 1st straight line patterns that said 2nd mask pattern has line width substantially comparable as said 1st linear pattern, and were arranged periodically crosswise [of said 1st linear pattern], It has line width substantially comparable as said 2nd linear pattern, and two or more 2nd straight line patterns arranged periodically crosswise [of said 2nd linear pattern] are included,

Said deformation illumination conditions at the time of transferring an image of said 2nd mask pattern, Intensity distribution of illumination light in said optical Fourier transformation plane, The transfer method

according to claim 7 or 8 becoming distribution centering on four positions which met in the direction rotated 45 degrees substantially, respectively from a direction corresponding to a long side direction of said 1st and 2nd straight line patterns centering on said optic axis.

[Claim 10]Said gate pattern contains the 1st gate pattern containing the 1st linear pattern and the 2nd gate pattern containing the 2nd linear pattern that makes a longitudinal direction a direction which intersects perpendicularly with a long side direction of said 1st linear pattern,

Said 1st mask pattern contains a pattern which has the form corresponding to said 1st and 2nd gate patterns, respectively,

Two or more 1st straight line patterns that said 2nd mask pattern has line width substantially comparable as said 1st linear pattern, and were arranged periodically crosswise [of said 1st linear pattern], It has line width substantially comparable as said 2nd linear pattern, and two or more 2nd straight line patterns arranged periodically crosswise [of said 2nd linear pattern] are included,

The transfer method according to claim 7 or 8, wherein said deformation illumination conditions at the time of transferring said 1st straight line

patterns on said substrate differ from said deformation illumination conditions at the time of transferring said 2nd straight line patterns on said substrate.

[Claim 11]Intensity distribution of illumination light in said optical Fourier transformation plane uses Lighting Sub-Division conditions at the time of transferring an image of said 1st straight line patterns as deformation illumination used as distribution centering on two positions which are separated from said optic axis in the direction corresponding to a direction which intersects perpendicularly with a long side direction of said 1st straight line patterns,

Lighting Sub-Division conditions at the time of transferring an image of said 2nd straight line patterns intensity distribution of illumination light in said optical Fourier transformation plane, The transfer method according to claim 10 considering it as deformation illumination used as distribution centering on two positions which are separated from said optic axis in the direction corresponding to a direction which intersects perpendicularly with a long side direction of said 2nd straight line patterns.

[Claim 12]The transfer method according to claim 11 currently forming

on a mask different, respectively from said 1st straight line patterns and said 2nd straight line patterns.

[Claim 13]The transfer method according to any one of claims 1 to 12, wherein said 1st and 2nd exposing conditions contain a light exposure when transferring said mask pattern.

[Claim 14]The transfer method according to claim 13 making a light exposure when transferring said 2nd mask pattern larger than a light exposure when transferring said 1st mask pattern.

[Claim 15]The transfer method according to any one of claims 1 to 14, wherein said 2nd mask pattern contains a translucent section to which about 180 degrees of phases of illumination light irradiated by this mask pattern are shifted.

[Claim 16]Said 1st [the] and said 2nd mask pattern are formed in a mask mutually different, respectively,

The transfer method according to any one of claims 1 to 15, wherein said each mask is arranged one by one at the object face side of said projection optical system so that a longitudinal direction of a portion corresponding to said linear pattern and period directions of said 2nd

mask pattern may intersect perpendicularly among said 1st mask pattern.

[Claim 17]Two or more said 1st mask pattern adjoins, and has straight line patterns of form corresponding to said linear pattern,

The transfer method according to any one of claims 1 to 16 adjoining on said substrate and forming two or more gate patterns provided with said linear pattern by transferring said 1st mask pattern on said substrate.

[Claim 18]A device manufacturing method including a process of transferring a device pattern formed on a mask on said substrate, using a transfer method of Claims 1-17 given in any 1 clause.

[Translation done.]